3.1. SETTING.

3.1.1. Location. The Hawaiian Islands occupy a position just south of the Tropic of Cancer at Latitude 23.5° North in the center of the Pacific Ocean. These volcanic islands have been weathered to various degrees and support a broad range of environments, from dry savannahs to wet tropical forest. The total land area of the principal islands is approximately 16,800 square kilometers (6,500 square miles).

3.1.2. Geography. There are over one hundred islands in the Hawaiian Island chain, however, there are eight principal islands. From west to east these are Niihau, Kauai, Oahu, Molokai, Maui, Lanai, Kahoolawe, and Hawaii. They are hilly or mountainous and about one-fourth of the land rises less than 200m (650 ft) from sea level, one-half lies between 200 and 600m (650 and 2,000 ft) in altitude, and another one-fourth reaches elevations of more than 600m (2,000 ft). Hawaii, the largest and most easterly of the islands, has peaks higher than 3,900m (13,000 ft), and active volcanoes. Coastlines are mostly rocky and rough. Only the islands of Oahu, Kauai, and Niihau have much in the order of coastal plains. Surface streams are few because the ground is composed of porous soils.

3.1.3. Climate. The prevailing northeast trade winds, ocean currents, and location near the equator maintain a tropical climate throughout the year. Temperature and precipitation remain nearly constant year-round at any given location, but both vary greatly with altitude and aspect. Average temperatures at sea level range from about 21° C (70° Fahrenheit (F)) in January to about 24° C (75° F) in July. Frost is rare below 1,200m (4,000 ft) and has never been recorded below 800m (2,500 ft). On the highest peaks, however, snow may fall any month of the year. Precipitation is heaviest on the windward side of all the islands, while leeward slopes can be semiarid. USARHAW lands are only on the Island of Oahu and Hawaii and their climatic range varies based on location.

a. Island of Oahu. The Army land on Oahu is scattered throughout the island. Oahu, unique among the other islands, consists of two mountain ranges that greatly influence the local climate. These are the Waianae Mountains on the west side of the island, and the Koolau Mountains on the eastern side. Although the Waianae Mountains are higher than the Koolau Mountains, they receive less rainfall. The Koolau's intercept the moisture-laden trade winds from the northeast, causing high rainfall over the mountain range's upper elevations. This creates a rain shadow and reduces the moisture available for precipitation in the Waianae Mountains. Annual rainfall in the Koolau's averages more than 5,100mm (200 inches). In contrast, Honolulu averages about 510mm (20 inches). The considerable range in annual rainfall and topography results in a diversity of vegetation types, fuel moisture, and relative humidities.

b. Island of Hawaii. The Army land on Hawaii (PTA) is in the central portion of the island and occupies much of the saddle area between Mauna Kea and Mauna Loa Mountains at roughly 2,630m (6500 ft) elevation. Temperatures are mild, with cool nights due to the high elevations. The annual mean temperature is about 15.6° C (60° F) at lower elevations at PTA and 10° C (50° F) at higher elevations. The area occupied by PTA is subject to occasional fog and frost, with frequent light rains in the winter months. The area is also subject to "vog", a local term used to describe foggy conditions due primarily to emissions of volcanic dust and ash. Winds tend to be gustier during the winter, while light winds continue in the dry summer months. Average annual rainfall ranges from 102 to 406mm (4 to 16 inches). Annual rainfall is variable because PTA is in the middle of a trade wind inversion zone between 2,023 to 2,832m (5,000 to

7,000 ft) in elevation. Even a 100-meter change in elevation can sometimes make a noticeable difference in atmospheric conditions. Average relative humidity is about 60-80 percent in windward areas below the inversion level and less than 40 percent above. With less than 41cm (16 inches) of rainfall annually throughout much of the area, there is always the potential danger of fire at PTA.

3.1.4. Flora. Native plants form a variety of community types, including grassland, shrubland, forestland, and areas of moss-lichen. Most shrubland lies in coastal lowlands on the lee sides of the mountains, extending to higher altitudes where rainfall is slight. Forests grow above the shrubland on the lee sides of mountains, extending to sea level on the windward sides. Shrubs mixed with scattered trees grow on the upper slopes of the high mountains, above the forest zone. Mosses and lichens grow above the timberline, where rainfall is low and frost is frequent. There are several types of native forestland, reflecting differences in availability of moisture. One occurs on the dry leeward sides of mountains up to about 800m (2,500 ft). Wetter areas up to about 1,800m (6,000 ft) support a forest that includes ohia, one of the dominant native forest trees in Hawaii, and treelike ferns. A third type of forest grows above the ohia up to 2,900m (9,500 ft) on Maui and Hawaii. The koa tree is the largest native tree on the islands, and can reach a height of 18m (60 feet) and a diameter of 3.7m (12 ft). Vegetation varies from wet rain forests to dry desert scrubs. These ecosystems harbor an abundance of threatened and endangered species, many of which are endemic to the Hawaiian Islands. Because of human activities, an influx of exotic species from around the world have taken hold in native Hawaiian ecosystems. Many of these aliens are highly aggressive invaders that easily outcompete native species for sunlight, nutrients, and water and they pose a serious threat to the continued viability of the native flora.

3.1.5. Fauna. Because of their isolation, the Hawaiian Islands feature a limited but unique selection of fauna. There are no native snakes and only a few reptiles and mammals. There are large populations of water birds such as terns, tropic birds, boobies, shearwaters, and petrels. Native forest birds include hawks, owls, crows, thrushes, flycatchers and honey creepers. Several bird species are presumed extinct and others are near extinction. Many species of animals have been introduced since human settlement including the axis deer, feral pigs, cattle, sheep, and goats.

3.2. REGULATORY REQUIREMENTS.

3.2.1. Endangered Species Act.

a. The Endangered Species Act (ESA) of 1973 requires all federal agencies to carry out programs for the conservation of endangered and threatened species. In addition, each agency shall insure that any action authorized, funded or carried out, is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat. Endangered species have the highest biotic priority protection. If the candidate species is listed as federally endangered, threatened, or proposed for endangered or threatened status, the installation shall design and implement a management program that preserves and protects those species. A table of federally listed species is provided for each installation in Chapter 7. These species are shown in the Protected Resources map in each SOP.

b. Wildfire, as well as suppression and pre-suppression activities, can have significant deleterious effects on endangered species. Fire has both direct and indirect impacts on endangered species. The direct effect is mostly considered negative, as it could kill the species. Indirect effects include destruction or modification of habitat and a change in the species composition.

c. As required by the ESA, the Army shall conduct Section 7 consultation with the USFWS on actions that may affect listed species. Most of the threats associated with military training are due to the risk of fire and invasion of weeds. Completion and implementation of the IWFMP is considered a necessary part of the consultation for each installation.

d. AR 200-3, Natural Resources-Land, Forest and Wildlife Management, prescribes current Army policies, procedures, and standards for the conservation, management, and restoration of land and the renewable natural resources consistent with and in support of military mission and in consonance with national policies.

3.2.2. National Historic Preservation Act.

a. Section 106 of the National Historic Preservation Act of 1966, as amended, requires installation commanders to identify, evaluate, and take into account the effects of undertakings on historic properties in accordance with the procedures outlined in 36 Code of Federal Regulations (CFR) Part 800. Section 106 also requires consultation with the State Historic Preservation Officer when an agency action may have an adverse impact on eligible and historic properties.

b. Cultural resources can be found in all of the FMAs. Structures and features representing heiaus, house platforms, stone walls of canoe sheds, pens, corrals, graves, shelter caves, petroglyphs, paved trails, and agricultural areas are abundant. Most are constructed of basalt cobbles and boulders. Fires of low intensity and short duration are characteristic of grassy fuels that dominate the training areas and usually do not affect these resources. Fire suppression activities, especially bulldozer lines and to a lesser degree, hand lines, can severely damage cultural resources. However, fire can remove vegetation that would otherwise obscure cultural resources, thereby benefiting the cultural resource program. Specifics for each installation can be found in Chapter 7.

c. AR 200-4, Cultural Resources Management, prescribes Army policies, procedures, and responsibilities for meeting cultural resource compliance and management requirements. These policies are designed to ensure that Army installations make informed decisions regarding cultural resources under their control in compliance with public laws, in support of the military mission, and consistent with sound principles of cultural resource management.

3.2.3. Clean Air Act.

a. As a federal entity, USARHAW is subject to all of the applicable regulations included in the Clean Air Act. Wildfires do not fall under Clean Air Act regulations as they are considered an emergency situation, however, all other fire management actions are subject to the law. This includes emissions from prescribed fires, though there are exemptions available if the prescribed fire is being used to abate a fire hazard.

b. Sensitive receptors of poor quality air from USARHAW lands are many on Oahu due to the high population density. Because of its location far from most population centers, PTA has few sensitive receptors within a reasonable distance.

3.3. RESOURCE MANAGEMENT PROGRAMS.

3.3.1. Natural/Cultural Resource Management.

a. The Directorate of Public Works (DPW) Environmental Division, Conservation Section, administers the conservation program that protects the endangered species and historical sites on the installation. One of the primary wildfire protection priorities is installation natural and cultural resources. It is necessary to integrate fire and natural/cultural resource management planning with military preparedness and training.

b. All fire preplanning efforts must consider what impacts fire pre-suppression and suppression activities will have on the natural/cultural resources they are designed to protect. Fire fighting strategies must minimize impacts to rare and endangered species, cultural resources, and other resources (e.g. habitat, watersheds, historical and archaeological sites, etc.).

c. The DPW Environmental Division, Conservation Section staff can be of assistance to a fire manager by providing input for developing acceptable fire containment or control strategies to suppress wildfires while still maintaining the health of the overall resource(s). This natural/cultural resource coordination must take place during any fire planning, preparations, and fire suppression operations. During extended attack suppression activities, Natural/Cultural Resource staff should be members of an Incident Command (IC) team staff.

3.3.2. Integrated Natural/Cultural Resource Management Plans (INRMP/ICRMP).

a. The purpose of the INRMP is to ensure that natural resource conservation measures and Army activities on mission land are integrated and are consistent with federal stewardship responsibilities. Fire suppression forces must be aware of the locations of high value natural resources and avoid damage during fire suppression activities.

b. The ICRMP is the installation commander's decision document for cultural resources management actions and specific compliance procedures. ICRMPs are internal Army compliance and management plans that integrate the installation cultural resources program with ongoing mission activities, identify potential conflicts between the two actions and compliance actions necessary to maintain mission essential properties and acreage's.

c. A completed INRMP and a draft ICRMP are available for Oahu and the Big Island.

3.3.3. Ecosystem Management Plan.

a. The Environmental Office has recently completed an Ecosystem Management Plan (EMP) Report for Army areas in Hawaii. Through these efforts, the Army in Hawaii is attempting to achieve the delicate balance between training requirements and responsible land stewardship. Biological Sensitive Areas (BSAs) and Sensitive Ecological Areas (SEAs) have been designated (see Chapter 7 for individual installation details) and how units will interact with these has been outlined in the EMP. These BSA/SEA are one factor used to determine priority protection areas in the FMAs.

b. BSA's "depict areas with rare and/or endangered species. Training limitations are imposed on BSA-1 and BSA-2 areas, or those with the highest native natural resource value"

(USAG-HI 1998). “These are highest priority sites for management, encompassing high elevation summit areas and higher quality communities at lower elevations” (25th ID(L) 2001).

c. SEA’s “are areas designated for resource protection and subject to...training guidelines... Sensitive Ecological Areas combine protection of both natural and cultural resources, i.e., BSA-1, BSA-2, and Archaeological Management Areas” (USAG-HI 1998).

3.3.4. Integrated Training Area Management (ITAM).

a. The Integrated Training Area Management (ITAM) program provides a decision-making process and an action-oriented land management program to integrate Army training and other mission requirements for land use with sound natural resource principles. The program’s goal is to achieve optimum, sustainable use of training lands by implementing a uniform ITAM program which includes inventorying and monitoring land condition, integrating training requirements with land capacity, educating land users to minimize adverse impacts, and providing for land rehabilitation and maintenance.

b. The ITAM coordinator and the wildland fire program manager shall collaborate to develop a broad-based monitoring and research program that tracks the results of fire management actions and post-fire land condition trends. Some of the specific areas outlined in the ITAM program are revegetation and firing point rehabilitation projects, soil erosion control, monitoring of existing transects, vegetation surveys and troop environmental awareness programs. The ITAM program also plays an integral role and complements the wildfire program by providing assistance in planning post-fire restoration, rehabilitation, and revegetation of training areas when impacted by fires.

c. ITAM manages the GIS system and database in support of range operations, Land Rehabilitation and Management (LRAM), Land Condition Trend Analysis (LRAM), and Training Requirements Integration (TRI). GIS based programs are being developed and implemented as an integral part of the Army’s wildland fire management program. Fire managers are increasingly relying on GIS as another tool to assist in the problem solving process and in making critical decisions. By putting spatial data in an integrated system where it can be organized, analyzed, and mapped, users will be able to find patterns and relationships that were previously unrecognized. This in turn will give fire managers a better understanding of the problems associated with wildfires and take action to prevent fires caused by military training activities.

3.4. FIRE EFFECTS.

3.4.1. Fire Ecology. It is not the intent of this plan to determine the effects of fire on the native ecosystem on Army land. The ecosystem is not fire dependent and any fire in the ecosystem is considered detrimental to the sensitive balance found on Army land (except for limited prescribed burning of alien grasses for fuel load reduction).

3.4.2. Vegetation Effects. Of the ecological communities, shrublands and grasslands contribute most to the fire problem. Fire is a major threat to native taxa and natural communities in Hawaii. Few native Hawaiian plants and animals are adapted to wildfires, and none has been found to be dependent on fire for survival. Consequently, most native plants and animals perish during fires. Little is known about subsequent recovery. Fire is also a major disturbance that accelerates the conversion of native-dominated communities to alien-dominated ones. Fire destroys the native components, allowing aggressive alien species to become established. Fire can destroy native taxa directly, and degrade their habitat. Adapted to a low fire occurrence, native plants sometimes recover, but typically not to pre-burn levels when in competition with fire stimulated alien grasses.

3.4.3. Role of Fire. The ecological role of fire in Hawaii is consistent with other tropical areas, where fire, usually of anthropogenic origin, converts tropical forest to savanna and grassland. Pyrophytic grasses typically invade burned sites, thus rendering them more fire prone. Subsequent burns inhibit the reestablishment of tree species and intensify alien grasses and fuel problems. The view of ecologists in Hawaii is that natural fire was not a significant ecological or evolutionary factor before the introduction of humans and alien vegetation. Alien bunch grasses and matted perennials accumulate litter and have considerable dead foliage attached. They are highly fire tolerant and occur in high fire frequency regimes in their natural ranges. All re-sprout vigorously and establish from seed after fire. These non-native grasses have a higher moisture of extinction and are adapted to burn in high tropical humidities and carry fire under essentially all conditions except sustained rain. Most of the grasses originate in seasonal tropical, subtropical, or warm and humid temperate areas where they can burn under high relative humidities. Some foliage produces an oil that seems to increase flammability.

3.5. FUELS.

3.5.1. General Wildfire Fuels.

a. Vegetation is the fuel for any wildfire. Petroleum based fuels, wood products, and plastics that are associated with human development are normally not found in the FMAs. Structural facilities in training areas are addressed under structural fire protection programs. All vegetation is either already a fuel source or is a potential fuel source under specific conditions. The dry dead foliage, or litter, produced by all vegetation creates fuel for fire. Living vegetation becomes a viable fuel source when drought conditions dry the living plants sufficiently or when, during a wildfire, they are dried by the convective or radiant heat of the fire itself.

b. Fuel conditions are directly related to moisture patterns and seasonal rainfall. During short periods of no or low moisture, the burning potential of vegetation can persist throughout the year. Fluctuations in precipitation can also result in short periods of vegetation green up followed by periods of drying. Dry conditions contribute to an increase in dead foliage and litter in plant communities. The invasion of alien vegetation has altered native ecosystems dramatically, increasing fuels and making many sites prone to damaging wildfire. Invasive, fire prone grasses have modified the natural regime and as a result, fire promotes the degradation of the remaining native Hawaiian ecosystems. The spread and intensification of alien grasses increase the frequency and extent of fires. Specific vegetation/fuel types are described under each FMA SOP and Chapter 7.

3.5.2. Fuels Classification.

a. Fuels are a combination of the dead vegetative litter, dry or flammable standing foliage, and the live vegetation that can be dried and become a fire fuel. Fuels can be defined as the portion of the biomass, which is likely to burn if ignited.

b. Fuels are broken down into classes described by the amount of time or "time lag" that is required to change the moisture content of the individual fuel particle being classified. This time lag is the amount of time for a substance to lose or gain approximately two-thirds of the moisture above or below its equilibrium moisture content. The shorter the time lag the more responsive the fuels are to changes in environmental moisture.

c. There are four classifications. One-hour fuels consist of dead vegetation less than ¼ inch in diameter, the 10-hour fuel class is 1/4" to 1" diameter, 100-hour fuel class is 1" to 3" diameter, and the 1000-hour fuel class is 3" to 10" or larger diameter. Estimated behavior models for each FMA are discussed in Chapter 7.

d. The 1-hour classes of fuels are considered to be "fine fuels" and the most sensitive to ignitions. Calculation of the current moisture content of the fine or 1-hour fuels is based on weather conditions. These calculations are used to monitor the level of flammability of the fine fuels based on the amount of moisture they are estimated to contain. Careful monitoring of the estimated Fine Fuel Moisture (FFM) level will provide an accurate indication of fuel combustibility. It should be noted that these moisture percentages can change rapidly (within minutes) depending upon temperature and relative humidity readings. In fuel types dominated by 1-hour fuels, fine fuels become the most critical concern of a fire manager. This size class reacts rapidly to changes in weather conditions, and is the primary carrier of fire, especially in wind driven conditions.

3.5.3. Fuel Types.

a. Many plant communities have similar fuel classification characteristics. These plant communities are grouped into fuel types.

b. Plant communities were recently mapped using digital geospatial data for the Island of Oahu by the Kennaway *et al.* (Plant Community Mapping, Military Lands, U.S. Army Hawaii, Oahu. Center for Environmental Management of Military Lands. 2003). Fuels at PTA were previously mapped in a study by Shaw and Castillo (Plant Communities of Pohakuloa Training Area, Hawaii. Center for Ecological Management of Military Lands.1997). The plant community maps produced by these studies were grouped into fuel types for use in wildland fire management. These types have also been correlated, to the degree possible, with the 13 standard Northern Forest Fire Laboratory (NFFL) fuel models. In addition two custom fuel models have been developed for particular Hawaiian fuels. These maps are located in Chapter 7.

c. Vegetation at PTA is quite different from that found on Oahu and is addressed separately in a section devoted to fuels at PTA (see Section 7.6.2). The fuel type classifications on Oahu are presented below with their associated NFFL fuel model.

(1) Short Alien Grassland. These are comprised mostly or entirely of yellow bluestem/broomsedge bluestem (*Andropogon virginicus*) grasslands. Some shrubs may be present, but they are sparse and the primary fuel is the grasses.

NFFL Fuel Model 2

(2) Tall Alien Grassland. Grasslands that are dominated by guinea grass (*Panicum Maximum*), molasses grass (*Melinis minutiflora*), or a combination of these grasses are denoted

by this fuel type. Shrubs such as haole koa (*Leucaena leucocephala*) may be present as part of the fuel bed, but the grasses are the main component. This is the primary fuel of concern on Oahu and has received considerable scientific scrutiny. Because fires in this fuel type do not conform to predictions made by any of the NFFL models, a custom fuel model has been developed and validated to represent fires in these grasses. Though the model was built and validated using data from guinea grass, it is believed that it will work better than any of the NFFL models in molasses grass. These grasses often coexist, and domination of a specific site by either species is often in a constant state of flux. It is, therefore, not reasonable either to accurately map the separate locations of these species, nor to use a separate fuel model for each species. Thus a single fuel model will suffice.

Guinea Grass Custom Model

(3) Eucalyptus Forest. Another primary concern of fire managers on Oahu is the prevalence of various species of eucalyptus throughout USARHAW lands. These tall trees are fire prone and fire adapted and fires in stands of eucalyptus present a serious challenge to suppression crews if they get into the crowns of the trees. They also slough off large quantities of highly flammable bark that provide a fuel matrix conducive to the spread of fire. The understory may also be infested with guinea grass, though it is usually not dense enough to carry fire on its own. Paperbark eucalyptus (*Melaleuca quinquenervia*) is grouped into this category as well because of its physical features. As its common name suggests, it also produces flammable bark.

NFFL Fuel Model 10

(4) Ironwood Forest. *Casuarina spp.* sheds needles prolifically, producing a thick litter bed and duff layer. This fuel bed thick with fuels for fires and fires in ironwood stands can become intense.

NFFL Fuel Model 9

(5) Mixed Forest. This fuel type falls on the other end of the fire behavior spectrum from the grasslands and the eucalypts. Common species include O'hia (*Metrosideros polymorpha*), strawberry guava (*Psidium cattleianum*), and the shrub and herbaceous communities found on very steep slopes and cliffs. Fires tend to creep in the duff and surface litter and rarely flare up except under the driest and windiest conditions. Fuel moistures tend to be high, partly due to the high elevations, and associated higher rainfall, at which these communities are found.

NFFL Fuel Model 8

(6) Christmas Berry Shrublands. A major invader, Christmas berry (*Schinus terebinthifolius*) is found on most Oahu USARHAW installations in a variety of ecological settings. It tends to grow in pure or nearly pure stands, and produces very little fine fuel litter. It is this characteristic that results in fires of low intensity and spread rate. Under moderate conditions, fires may have difficulty crossing through even moderate size stands of Christmas berry, making these locations potentially strategic for suppression efforts.

NFFL Fuel Model 5

(7) Kukui Forest. *Aleurites moluccana* is almost always restricted to moist drainages and is, therefore, a good indicator of high moisture microclimates. Stands of this species may

represent boundaries that fires are unlikely to cross except under very dry conditions. Saturated areas, such as bogs, are also included in this fuel type. A custom fuel model has been developed to represent this fuel type based on eye witness accounts of fire behavior in kukui fuels. It has not been validated because kukui communities tend to be long and sinuous, rather than blocky, making prescribed burning difficult to impossible to use as a validation method.

Kukui Custom Fuel Model

(8) Developed/Denuded. Though technically not a fuel type, as there is little or nothing to burn, this is an important category because it represents existing barriers to fire. These may be locations where the vegetation has been removed through excessive use, or where urban development has created a fuel bed that is not prone to fire. Regardless of the reason, this fuel type represents locations that will not burn.

No Fuel Model

3.6. FIRE BEHAVIOR AND FUEL MODELS.

3.6.1. Fire Behavior. Fire behavior of the Hawaii fuel types are inadequately researched and documented for most fire management purposes. Insufficient fire behavior data from various fuel types make determining which of the standard fire behavior fuel models apply (1-13) difficult. Standard models may not apply to all Hawaii fuel types because fuel bed characteristics differ from those on which the standard fuel models are based. The native vegetation types have a low rate of spread and low intensities with occasional increases in the intensities when the fire burns into the 100-hour (1” to 3”) and the 1000-hour (3” to 10”) fuel class. Most species will carry fire at dead fuel moisture as high as 20-25% and relative humidities as high as 85-90%. Significant progress has been made in predicting fire behavior in the guinea grass (*Panicum maximum*) dominated grasslands which are abundant on Oahu. A custom fuel model has been developed and validated that accurately portrays fire behavior within that fuel type (Beavers 2001). Further fuel model development is necessary, particularly for the grassy species of PTA, most notably the invasive fountaingrass (*Melinis minutiflora*).

3.6.2. Fuel Models.

a. Standard fire behavior fuel models have been assigned to the various plant communities occurring throughout USARHAW lands. In addition, two custom fuel models are applied to vegetation which is not well represented by the standard models. Factors in the fire behavior fuel models are fuel loading in each time lag class, fuel bed depth, the surface area to volume ratio, the heat content of the fuel, and the extinction moisture. Fuel depth can be critical to fire behavior determination and is very important in the grass fuel types of Hawaii. Very deep grasses will permit the highest wildfire intensities, although not necessarily the most rapid fire spread rates. Seasonal changes in the amount of live biomass for perennial and annual species are very important to potential fire behavior. Grass fuel beds composed entirely of green material (e.g. an immediate post-fire stand of grasses) are difficult to burn. However, green grass can be “under burned” where the fire carries in a well-developed thatch layer when relative humidities and soil moistures are low. A vegetation map of all USARHAW installations has recently been completed and the vegetation communities represented therein have been reclassified into these standard and custom fuel models to visually depict the lay of the fuels on the landscape. See Chapter 7 for fuel models that apply to specific installations.

b. In addition to fire behavior fuel models, National Fire Danger Rating System fuel models have been assigned to each installation to aid in determining the threat of fire given the current weather conditions. The NFDRS provides an estimate of the risk a fire would present, should one be ignited. See the installation SOP's for specifics.

c. Fuels have been mapped to give spatial information on their distribution. Specifics for each installation can be found in Chapter 7.

3.7. FUEL LOAD.

a. Fuel load is described as the amount (weight) of flammable biomass that will buildup in a given area over time, or at a specific time. Fuel loading is normally measured in tons of biomass fuels per acre. Fuel loads in a given area can vary greatly depending on fuel types and environmental conditions, particularly soil moisture and soil quality.

b. Fuel loads are constantly in flux, and the more variable the vegetation type over time, the more difficult it is to assess the fuel conditions. Herbaceous fuels are the most difficult to estimate over time because they change so readily with alterations in climate. This problem is exacerbated in Hawaii due to the year round growing season.

c. Fuel loading is one of the primary factors in the fire behavior fuel models and the NFDRS fuel models. The DPW Environmental and the ITAM programs support the Wildfire Management program by providing continued vegetation surveys. These surveys will be used to the extent possible to monitor fuel conditions. However, most of these monitoring plots are located in native vegetation away from the primary training areas and are of little use in determining the condition of the lands on which ignitions are most likely to occur. Therefore it is necessary to regularly assess the fuel conditions in the primary training areas.

d. On USARHAW lands, grassland fuels (both annual and perennial) are the most common and are fairly homogenous compared to other fuel types. Grass and herbaceous fuels are fine structured, and thus have a high surface area to volume ratio that permits rapid responses in fuel moisture to changes in atmospheric moisture. Post-fire development to pre-burn levels of biomass occurs within several months to years, and is often higher than 10 tons/acre, very high for a grass fuelbed. The dead fuels also increases rapidly in this fuel type and contribute to fuel continuity at the ground surface. Estimates of fuel loading for critical FMAs can be found in Chapter 7.

3.8. FIRE HISTORY.

3.8.1. General History.

a. Non-human caused fires in Hawaii have always been uncommon due to a lack of ignition sources and the relatively moist environment that covers the majority of the islands (Mueller-Dombois 1981, Smith and Tunison 1992). Lightning is infrequent and is usually accompanied by precipitation, and dry lightning is extremely rare. Lava-ignited fires do not burn enough area in comparison to the area covered by the flow itself to be of any significance (Vogl 1969).

b. Human colonization brought with it the introduction of fire as an agricultural tool and as a side effect of other activities. Effects on most native plant species are not well understood, but anecdotal evidence suggests that areas that are disturbed by fire tend to be overwhelmed afterwards by highly aggressive non-native invaders. There are many possible reasons for this, though the most likely explanation is that the exotics have evolved in ecosystems in which they were surrounded by competitors, herbivores, and disturbance regimes that pressured them to develop characteristics that allow them to respond to fire with more vigor than species that have evolved in non-fire prone areas, such as the natives of Hawaii. The exotics are from highly competitive ecosystems that are subject to frequent fire and heavy grazing and therefore have developed a strong ability to resprout from belowground organs and/or germinate quickly from seed (Pyke 1987, Freifelder et al. 1998). When released into an environment in which many ecological niches are vacant or filled with comparatively poorly fire-adapted species, the exotics flourish.

3.8.2. Fire History on Army Lands. The entire Hawaiian ecosystem, including Army lands, has experienced an increase in fire frequency in the recent past. This is due to many factors, mostly the spread and intensification of alien grasses, and, on Army land, technological advances in ammunition and supporting pyrotechnic devices used for training. An attempt to reduce this frequency began in 1991, with the application of a fire prevention and prescribed burn program. Past fire history records for all training areas are sketchy and inconsistent, making an evaluation of the fire prevention program impossible. Most fire history files are incomplete and were primarily retained as manual records. These were destroyed following disposition of records (after 5 years) in accordance with the Modern Army Record Keeping System (MARKS). Fire history analyses, based on available records for each FMA, can be found in Chapter 7.

3.9. IGNITION SOURCES.

a. There are several sources of fire ignition on Army land. They are divided into three categories: natural, arson/accidental, and military activities. Most ignitions on Army land result from military activities. The Army experiences a high incidence of wildfires which cross all types of borders, be they political, ownership, land use, or vegetation type.

b. Natural ignition sources are rare in Hawaii. There is evidence of natural fires started around the state by lightning and volcanic activity. Because of climatic conditions and location, these occurrences are very rare on Army land. However, natural fires have started elsewhere and spread onto Army lands.

b. Arson and/or accidental fires occur occasionally on Army land. Ignitions from children playing with fire, smoking, power lines, and vehicles (which make up the majority of ignitions on most public lands) are only a small fraction of the total number of fire starts on Army land. Fireworks play an important part in the local culture. Many types of fireworks are legal and are used several times during the year. Deliberate arson occurs occasionally.

c. The military activities associated with training introduce the risk of unplanned fire ignitions with the use of ammunition and pyrotechnics. The principal ignition sources on Army land are tracers, pyrotechnics, illumination rounds, and explosive ordnance. The live ammunition and incendiary devices used on Army ranges during training provide ignition sources and cause numerous wildfires each year in the FMAs. These are by far the largest source of ignitions on the live-fire ranges.